Ecological concepts in raw hide conservation (preservation)

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Much of the research on improving rawstock, at the United States Department of Agriculture's Hides, Lipids and Wool Research Unit laboratory on improving raw stock revolves around the elimination of the environmental problems associated with brine (sodium chloride) curing.

Recent approaches to this objective include:

1. Electron beam irradiation, a curing process that eliminates salt and maintains the hide in an essentially raw hide state.
2. The use of potassium chloride as a direct replacement for salt resulting in an environmentally friendly effluent from the process.
3. Development of a chemical means to remove hair from cattle before the hide is removed. The work has been continuing for more than eight years in cooperation with Monfort* of Colorado, the red meat division of Conagra, Inc.

None of this research is in its final form but the direction of the work shows the importance of the need today to reduce the impact of all manufacturing process on the environment.

Changes in manufacturing approach to eliminate salt

Two major changes have taken place within the last ten years in the packing and tanning industries which I believe are an indication of just how much pressure there is to eliminate salt curing. The first is that the largest tanner in the world is a meat packer. I believe that one of the compelling considerations that went into the decision by Iowa Beef Processors [1] to begin tanning cattle hides was the difficulty they encountered in disposing of their excess brine.

The second major change is still occurring in the tanning industry. That change is the increasing use of fresh hides as the raw material for leather manufacture in place of salted hides. Several of the largest United States tanneries are going to great lengths to use fresh hides in as much as 60% of their production. To do this hides are iced down at the packing plant, placed in refrigerated trucks and, in some cases, transported as much as several hundred miles to the tannery within twenty four hours. While most tanners feel that the overall quality of leather produced from a fresh hide is better than that from a cured hide, they are equally concerned about the concentration of dissolved solids in their effluents.

While this latter change eliminates the problems associated with brine effluent, it creates problems for the tanner in terms of flexibility in selecting raw stock quality. Once under contract to purchase fresh hides the tanner must accept all of the hide variations in the cattle brought to the packing plant that day, and all of that rawstock must be processed immediately.

The research presented here offers solutions that not only eliminate salt but produce a cured hide with extended shelf life permitting the tanner to make more precise selections of raw stock.

ELECTRON BEAM IRRADIATION

Electron beam irradiation preservation produces a hide with fresh hide characteristics combined with an extended shelf life. The basic concept of this process has been described in several papers. Electron beam irradiation completely eliminates both salt and the dehydration of the hide that is associated with brine curing. This hide preservation process has been patented by Ionizing

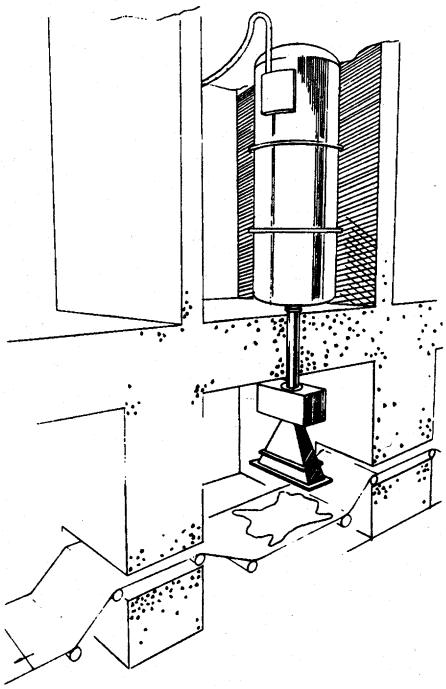

Illustration of the interior of an electron beam facility irradiating whole cattle hides.

Energy of Canada and the name "Evergreen" applied to irradiated hides because they so closely resemble green hides.

Tanners objected to two disadvantages of the early work:

1. Each hide had to be individually enclosed in plastic to eliminate recontamination with micro-organisms after irradiation. Individually packaging each hide to maintain a sterile environment only adds to the cost of the preservation and to solid waste disposal problems.
2. Associated with the irradiation treatment was up to 10% loss in tensile strength in the final leather. The Research's Unit's most recent laboratory experiments in this area appear to overcome these objections.

The experiments were designed to

examine the effect of electron beam irradiation on the shelf life of refrigerated hides while reducing or eliminating the individual hide packaging requirement.

Irradiation: the effects of moisture and chilling

Laboratory scale experiments demonstrated that refrigeration significantly increased the shelf life of irradiated samples compared with room temperature storage. On this basis we proceeded to pilot plant scale experiment that introduced a new sample preparation technique allowing the use of a commercial wringing machine to effectively remove excess moisture from the hide samples prior to irradiation.

One of the difficulties encountered with small scale preservation, up to this time, was removal of the excess liquid from the samples after treatment with bactericide. In this experiment instead of the small rectangular samples, ten inches on each side, strips of hide, eight to ten inches wide were cut from the hide perpendicular to the backbone. These pieces were 30 to 40 inches in length and therefore long enough to wring in a commercial hide wringer.

The samples were treated with preservative and subjected to two sided 3MEV irradiation at levels of 0.6, 1.0 and 1.6 MRads. The irradiated samples were loosely wrapped in clear plastic and stored in a 4°C walk-in refrigerator exposed then to whatever contamination might be circulating in the air. After nine weeks the first set of samples was removed from storage. The samples were remarkably similar to the hide samples as originally placed in the refrigerator. There was no evidence of deterioration in any of the samples; however, the edges of many of the hide samples were extremely dried out. It appeared that these areas might not rehydrate and therefore tan poorly.

This experiment was repeated except this time the hide samples were carefully wrapped, in groups of nine, to prevent excessive dehydration during storage. A similar situation is encountered when shipping blue stock, where drying is prevented by wrapping entire pallet loads of blue stock in plastic.

No loss in tensile strength

At the end of twenty-six weeks these samples appeared to be as fresh as when they were placed in the cold room. Three or four of the original fifty-six samples had small colonies of mould growing on the hair side but there were no other signs of deterioration. The odour was fresh and the hair was tight on every sample.

When the irradiated samples were tanned some grain damage was observed. The damage was related to the level of irradiation and not the degree of drying out. The damage occurred during wringing when the pressure of the wringer caused a separation of the grain from the corium. This only occurred at 1.0 and 1.6 MRad levels of irradiation, and the samples from the lowest level, 0.6 MRads, were not damaged in any way. There was no loss in tensile strength in the irradiated samples compared with the control samples.

These results indicate two very significant advances in our knowledge of the electron beam irradiation preservation of cattle hides:

1. A combination of refrigeration and irradiation produced excellent preservation for six months even at the lowest level of irradiation tested, 0.6 MRad. Un-irradiated control samples began to deteriorate within two weeks.
2. There was no apparent loss in physical strength as a result of the irradiation. Reducing the moisture content of the hide lowered the required level of irradiation needed for effective preservation. The tensile strength of even the 1.0 MRad treated samples was not significantly different from control samples tanned at the same time. This is consistent with the results of irradiating high and low moisture content leather first reported in 1988. Identical levels of irradiation reduced the physical strength of high moisture containing leather considerably more than the same leather at a low moisture level.

POTASSIUM CHLORIDE PRESERVATION

The idea that one salt, potassium chloride, could be substituted for another, like sodium chloride, to cure a hide seems obvious. What is not obvious is what would be the point in doing so.

This research began with a call from Joe Gosselin, a senior research chemist from Kalium of Canada, asking if we would be interested in setting up a joint research project to determine if potassium chloride could be used in place of salt for curing hides and under what conditions. When Joe explained that his company sold 7 million tons of potash to the North American agricultural community for fertiliser last year, that potassium chloride was a plant macro nutrient and that the excess potassium chloride brine produced during raceway curing of cattle hides could be disposed of in almost limitless quantities as a fertiliser, we became extremely interested. The only question became, "what would be the effect of potassium chloride curing on leather quality?"

What follows is a summary of what we have learned so far and a discussion of the potential advantages and disadvantages of potassium chloride over sodium chloride.

From initial investigations to bulk trials

While it was Joe Gosselin of Kalium who called to initiate this project, the idea had come from Pat Gummerson, the Production Manager of Lakeside Packers

Pat Gummerson of Lakeside Packers, Brooks, Alberta marking the first set of paddle cured potassium chloride cured hides.

in Brooks, Alberta, Canada. Pat soaked a piece of cattle hide in potash (potassium chloride) solution overnight, allowed the excess solution to drain off for a few days and then sent the treated hide to a tanner to see if it could be made into leather. The tanner saw no difference between the piece sent and the brine rawstock he normally processed.

Initial laboratory scale experiments demonstrated that small samples of fresh cattle hides soaked for several days in four molar (concentration) and higher potassium chloride could be preserved at room temperature for five months. Samples held at 104°F did appear to breakdown after this period of storage. These results were confirmed using two foot square hide samples treated overnight in a drum containing saturated potassium chloride. From this we went to a 100 matched side study with the hides preserved at Lakeside Packers and tanned at Dominion Tanners in Winnipeg, Saskatchewan, Canada.

One hundred hides, fresh from the kill floor, were sided at Lakeside Packers. These hides were soaked in a paddle for two hours at 110°F water, to loosen and remove manure, fleshed and sided. Each side was identified using a system of punched holes. Alternating right and left sides were either sodium chloride brine cured in a raceway or potassium chloride brine cured in a paddle. After twenty-four hours the hides were removed from the brine and safety salt added. The cured hides were placed on pallets for storage until shipped to the tannery.

After five weeks all of the cured sides were shipped to the tannery. Exactly forty days after curing, each side was examined before being placed in a drum to be soaked, unhaired and limed. The condition of both the potassium chloride and the sodium chloride cured hides was excellent. The potassium chloride cured hides contained more moisture. There was no hair slip nor odour problems in either cure. After liming the sides were fleshed and tanned together in the same drum with additional full hides added to make up a full pack.

A normal blue sort into three grades of heavy and medium weight leather was carried out after wringing. The result suggested that there was no significant difference between the two treatments. Each of the sides was graded for break and the area measured. A slight difference in draw in favour of potassium chloride might correspond to the reduced dehydration seen in potassium chloride. Comparing only the matched pairs with each other, 59% had the same draw, in 18% of the pairs the sodium chloride had less draw and in 28% of the pairs potassium chloride sides had less draw. The area difference was small and not statistically significant. Tensile strength was measured on each of the matched pair of sides in the crust and there was no significant difference between treatments.

The work described up to now suggests that leather produced from potassium chloride cured hides cannot be distinguished from leather produced from sodium chloride preserved hides. However, the storage time in these experiments was limited to forty days, not long enough for trading in today's worldwide markets.

Long term protection

In order to test the length of preservation further a second large scale experiment was conducted. Curing was again done in paddles at Lakeside Packers. This time 150 test hides were shipped to Teh Chang Leather Products in Taiwan along with 500 sodium chloride raceway cured hides. The total time that elapsed between hide take off and tanning in this case was three and a half months. Upon examination of these hides, in the hide house the day before they were put into process, there were two noticeable differences between the two cures:

1. The red colour associated with halophilic bacteria was quite noticeable on the brine cured hides but not on the potassium chloride hides.

2. The potassium chloride cured hides were considerably drier on the outside areas of the hides exposed to the air compared with the corresponding areas on the sodium chloride cured hides.

There was some concern at this point about rehydration of these hides, however, the interior hides on the pallet appeared to be in good condition.

Every hide was evaluated for break after liming. The average break for each set was not significantly different. The potassium chloride cured limed hides were firmer than the sodium chloride cured hides. The handle in the blue appeared to be the same.

Shrinkage after a two minute boil was 95% for the potassium chloride hides and 96% for the sodium chloride hides, with the shrink temperature for both greater than 96°C.

The blue stock was graded into four categories, A, B1, B2 and C. The results of the potassium chloride sort were 15.8, 28.4, 8.27 and 2.88%. Sodium chloride sort was 20.0, 23.0, 7.5 and 2.33%. Again the difference between cures, even after four and a half months, was very small and probably not significant.

Since the evidence is good that potassium chloride can replace sodium chloride for hide preservation, what are the practical considerations that will affect the adoption of potassium chloride curing?

1. Cost: potassium chloride costs more than sodium chloride per pound. The significance of this difference will, however, vary greatly with the location of the packing plant and the difficulty (and cost) of getting rid of the sodium chloride brine now produced in the hide processing area.

2. Potassium is a plant macro nutrient which means that all plants require large quantities of potassium for growth. For some plants, alfalfa for example, the uptake of potassium is quite high and the added potassium is removed from the field entirely at harvest. A five thousand hide a day packing plant, producing potassium chloride brine, at the same rate it now produces sodium chloride brine, would require only 15,511 acres of alfalfa to consume one year's production.

3. Solubility of potassium chloride varies with temperature. This will be a disadvantage for hide processors because it means that in cold weather the hide processing area or at least the raceways will have to be temperature-controlled to a greater extent than they are now. If the temperature

drops, then the solubility of potassium chloride decreases and the level of potassium chloride needed in the hide for preservation will not be achieved.

The primary beneficiary of this process will be the meat packer and the independent hide processor. They have the most severe effluent problems as a result of brine curing with sodium chloride and they have the most to gain from using potassium chloride as a hide preservative. While effluent dissolved solids may be a serious problem for a number of specific tanners, it is far less important than some other environmental issues now before them.

This work is continuing with experiments examining the impact of potassium chloride curing of cattle hides in raceways, processing of pigskins in processors and calfskin preservation in salt packs.

DEHAIRING ON THE RAIL

Finally just a brief comment on the unhairing of cattle prior to the removal of the hide. Monfort* has come a long way since the original experiments were done on small pieces of hide in the pilot plant tannery at ERRC. After submitting extensive applications to the U.S. Department of Agriculture Monfort* was allowed to construct a pilot plant to apply the chemical unhairing system to a limited number of cattle after stunning.

When the dehairing was complete these animals were transported to the packing plant floor to remove the hide. Test hides were sent to tanners for evaluation and at this point the process looks very promising.

The major hurdle to cross now, before going to a larger pilot plant test, is waste treatment of the excess unhairing chemicals. Direct discharge to the waste treatment facilities at the packing plant is not feasible and it appears that the next step is to design and construct a closed system to recycle some of these chemicals rather than dispose of them.

In a soon-to-be published paper, Monfort* states that unhairing prior to hide removal has not been as effective as anticipated in eliminating microbial contamination. This is a clear demonstration that the packing industry is already doing an excellent job in preventing contamination of the carcass by the hide as it is removed. Additional work will need to be done to identify the source(s) of the remaining contamination and to implement clean carcass handling practices further down the line to prevent recontamination of the carcass.

Legend:

* Monfort is one of the major US packers, with five beef processing plants in Iowa, Texas, Nebraska, Kansas and Colorado. The five plants have a weekly capacity in excess of 125,000 head of cattle. The company employs more than 9,500 people and it has an annual turnover in excess of $7 billion. Its largest plant is in Greeley, Colorado, where 2,270 people are employed. The kill capacity is 5,600 a day where its selection covers branded steers, light hides and Holsteins.

(1) Profile IBP *World Leather* October/ November 1994